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THE IRON AND STEEL INDUSTRY IN A DEVELOPING ECONOMY

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THE IRON AND STEEL INDUSTRY IN A DEVELOPING ECONOMY

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I. INTRODUCTION

1. The establishment of an integrated iron and steel industry in a developing economy creates a great new driving force which experience demonstrates provides the basis for rapid economic, industrial, and social growth, and the decision by a developing nation to create an iron and steel industry begins a long chain of events which require the most careful and professional planning in a large number of fields.

2. Before a decision of this magnitude is made, responsible officials need to weigh carefully the many considerations involved. This paper is intended to be of assistance in this regard and is divided into three parts: First, prerequisites for building an iron and steel plant; second, the benefits which accrue to the economy when a basic iron and steel industry is established; and third, the step by step evolution of such a project.

II. PREREQUISITES FOR BUILDING AN IRON AND STEEL PLANT

3. Despite the attractiveness of the idea of creating an iron and steel facility, there are definite prerequisites which must be fulfilled before any steel mill project can be wisely undertaken. This cannot be overemphasized.

4. Whether or not these prerequisites can be fulfilled, however, can be determined only through a very careful survey and analysis by specialists in a number of key areas. These prerequisites are: -

(a) Adequate markets -- based on present consumption and predictable growth to support a minimum economic sized plant.

(b) Adequate raw materials at reasonable cost.

(c) Adequate transportation at reasonable cost for raw materials and finished products.

(d) Good site location accessible to raw materials (including water), markets and labor supply.

(e) A satisfactory financial plan for construction and operation of the plant.

A. Adequate Markets

5. None of the benefits of an iron and steel industry is possible, unless there is a sufficient internal market for steel products to support an economically sized steel producing facility. Therefore, the first step to be taken to determine the economic feasibility of establishing a steel industry is to undertake a well-planned market survey. Quantities of iron and steel imported in the past serve as a convenient starting point.

6. If the statistics available in the country are inadequate to establish this point, then this information can be obtained from the records of importers of these products. To predict the future growth is sometimes difficult because, in a rapidly developing economy, previous economic history is not indicative of future growth after steel products become available locally at steady prices. Prediction of future trends depends upon a study of conventional indices; such as, the gross national product, population growth and combination of statistical facts which may seem reasonable and relevant in the light of present conditions. Of special significance here, is the use of information on trends in other developing nations comparing what has happened before and after the building of the steel plant.

7. Once total steel consumption has been established, it is necessary to spell out the various end uses of the products. These end uses include such things as reinforcing rod for concrete construction, round rods for wire and nails, small angles and channels for construction, pig iron for independent foundries, structural shapes for construction of buildings and machinery, flat sheets for siding and roofing, utensils and hollow enamelware, containers, and tinplate.

8. The quantity of each of the products which the mill is to make must then be carefully estimated. This information is used to determine the size of mill to be designed to satisfy the markets immediately available, and as projected for the immediate future. It is important to understand that it is seldom practical to propose a plant that will make all of the sizes or all of the types of steel products that have been imported in the past. It would not be economic to make a small quantity of a given product, particularly if the market forecast for this product were also small. Therefore, it is necessary to design the plant to produce the greatest number of those products which it can make most economically.

9. It is interesting to note that in steel plant projects in developing economies there is a pattern of growth which usually begins with the production of merchant products required for construction applications, such as concrete reinforcing bars and angles, and then proceeds eventually to flat steel products necessary to a more highly industrialized economy.

10. Consideration of all these factors will result in an estimate, by classification of products and individual sizes, of the total iron and steel requirements for the next ten years which is about as far ahead as one can make a reasonable prediction.

B. Raw Materials

11. Accessibility of adequate raw materials at a reasonable cost is vital to the development of the plant. And as it will be necessary that proven reserves, or assured sources, of the various raw materials shall be available to serve the plant for a period of 20 to 25 years, a scientific program of drilling and testing under competent supervision must therefore be undertaken. This program must prove not only the quantity of the raw materials available, but also their physical and chemical characteristics. The costs of mining and transporting

these raw materials to the plant site must also be established, and these costs must be reasonable or the economic soundness of the entire project may be jeopardized. If insufficient quantities are available, or poor qualities of raw materials are encountered, it may be necessary to consider importing such materials, or at least importing a portion of the total requirements, if the economics justify doing so.

12. A firm commitment for adequate supplies of these materials must be obtained at definite prices on which to base the economic viability and financial projection of the project.

C. Transportation

13. Next comes accessibility and transportability of raw materials at a reasonable cost. Also, consideration must be given simultaneously to the cost of moving the finished products of the plant to consuming markets. Excessive costs here, even with all other factors favorable, could defeat the project.

14. The most desirable and cheapest form of transport is by water; that is, river, lake or ocean. Other methods of transport are railroad, aerial ropeway, and highway. Each method has its own pros and cons as compared with the others. Hence, it is necessary to make a thorough investigation of the cost of transport of materials to and from the various plant sites selected for investigation.

D. Plant Location

15. Plant location can often make the difference between profit and loss in steel plant operation. In addition to the obvious factors of accessibility to raw materials and markets, and the cost of transportation, the land must be obtainable at a reasonable cost. The land must also have good soil-bearing conditions to carry the heavy loads and not require extensive piling or other site-preparation costs. In addition, the site must provide adequate supplies of potable and process water and be situated so that it will be easily served by good housing, schools, hospitals, utilities and other facilities for workers and their families. Highways, roads, airports, waterways, transportation service into the plant are also required for a well located plant.

16. In the event that it is necessary to locate the plant in an undeveloped part of the country, it may be necessary to construct a complete town site at that location, and provide all the necessities of a town or village. When this happens, it adds to the economic burden of the steel plant project if the cost of these facilities must be charged to it. Experience indicates, however, that local governments are often willing to subsidize the town site development in order to make the project possible, to decentralize their industries, and to bring about the development of a new portion of the country. In this event, the iron and steel plant is relieved of this financial and administrative burden.

E. Financial Plan

17. Sufficient funds must be provided on reasonable terms to finance the construction and initial operation of the plant. The loans must be on a long enough term and at low enough interest rates to permit the plant to be economically viable.

18. With satisfactory answers to these five prerequisites, possible benefits may now be evaluated and the characteristics of the project determined in terms of plant design, capital cost, financing and plan of operation.

III. BENEFITS

19. It is well known that the consumption of iron and steel products is a barometer of economic, technical, and social growth. Examples could be cited showing that the advent of an iron and steel plant in some of the recently developing nations resulted in economic advancement. In addition, the development of an iron and steel industry promotes certain other immediate benefits which include local availability of steel products as compared with imports, large-scale employment of local labor, and conservation of foreign exchange.

20. While the primary benefits created by the introduction of an iron and steel industry are of great importance, the other benefits which are in turn created play a very significant role in spurring economic growth. For instance, it has been learned by experience that for each individual employed directly in an iron and steel mill approximately eight to ten persons will find employment in supporting industries such as the mining of iron ore, coal and limestone, and in the transportation services associated with the plant. A tertiary effect is the generation of other smaller servicing businesses that find their mainstay of support in the industries created. In addition to this, as a result of local availability of steel at steady prices a wide variety of consuming industries come into being for converting the steel mill products into finished and semi-finished goods. The local steel mill provides a basis for confidence among people who desire to go into business because they are assured of a steady supply of these steel products.

21. Because of their need to import a large number of finished products, many developing countries find themselves with a major problem of conserving foreign exchange. Hence the introduction of an iron and steel industry and the substantial reduction of iron and steel imports which this brings about make it possible to conserve foreign exchange and bring the economy of the country into better balance. The full realization of this saving is made possible when the raw materials for the production of steel are indigenous. Quite obviously, if a steel mill were built on the premise of importing some or most of its raw materials, the advantage which would accrue to the country would be correspondingly reduced.

22. Because the greatest quantity of products needed initially by a developing economy follows a pattern, it can be stated that even a small steel plant with a capacity of only 150,000 metric tons per year producing only a partial range of steel products well selected according to local market demand may be able to supply a very large percentage of the total finished steel requirements.

23. Thus we find that in most cases the creation of an iron and steel industry in a developing country introduces a dynamic, driving force that provides a real basis for rapid economic, industrial, and social growth.

IV. EVOLUTION OF AN IRON AND STEEL PLANT

A. Size of Plant

24. Using the information furnished in the market survey, it is possible to determine the size of plant which should be built to satisfy the market for the various products required by the economy. It may be that the required quantities of one product are insufficient to justify expenditure of huge sums for the specialized equipment necessary for its production. For example, if a country had a market for a small quantity of high quality tinplate for its canning industry, say 20,000 tons of electrolytic grade, and had no use for other flat

products, it would be impractical - cost-wise - to build a good flat product mill to produce such small tonnages of this high quality product. The same would be true if a small quantity (say 5,000 tons) of large structural members or a small quantity of railroad rails were required. Providing the facilities for such small-scale production would increase costs beyond the point of economic feasibility.

25. It is necessary, therefore, to decide on a plant of such size as to produce economically the greatest possible number of products required by the growing economy.

B. The Iron-Making Process

26. Once the size of plant has been determined, and the raw material costs and availability established, it then becomes necessary to select the iron-making process best suited to that size of plant and those raw materials. In some developing countries the selection of a suitable iron-making process is much more complex than in the highly industrialized nations of the world due, generally, to the small plant capacity required coupled with the lack of one or more of the basic materials in the quality and quantity usually considered acceptable. Subject to the availability of raw materials and the planned size of plant, any of the following processes may be adopted:

(a) Blast Furnace - The conventional blast furnace normally operates with high grade, lump iron ore (or sintered or pelletized iron ore) which is low in contaminants such as titanium, zinc, nickel, chrome, copper, and the like. A good grade of metallurgical coke must be used. This type of furnace is highly efficient and is preferred when the capacity required is sufficiently high, and when high grades of iron ore and coking coals are available. It is ideally suited to continuous operation at larger tonnages. If smaller tonnages are required, however, and if good grades of iron ore and coking coal are available, and electric power can be furnished at reasonable rates, then consideration might be given to the iron-making process described below.

(b) Submerged Arc Electric Smelting - The submerged arc electric smelting furnace may be built for capacities as low as 100 metric tons of pig iron per day. The advantages of this furnace over the blast furnace described above are that it can give acceptable economics at smaller tonnages, and it uses electricity which may be available and cheaper than other sources of heat. The major disadvantage is that, in the larger sizes, it costs more to produce pig iron by this method than by the blast furnace under normal conditions.

(c) Electric Reduction Processes - The need for a process that can treat off-grade iron ores, or can use non-coking coals with low or high grade iron ores, has been evident for many years. During the past few years a number of such electrical reduction processes (often referred to as direct reduction processes) offering certain technical and economic advantages have evolved. After an exhaustive study of those developed in the past ten years, Koppers Company decided that the Strategic-Udy process is the best of these processes applicable to the above conditions. The Strategic-Udy iron-making process heats and partially reduces the iron ore, coal, and limestone in a rotary kiln. This heated and partially reduced mixture is then introduced as a free-flowing sinter into an electric furnace where the final reduction takes place. It is not able to compete with the blast furnace when tonnages are large and other conditions are proper for that type of operation. However, if the capacity of the plant is small, if the available iron ore contains copper, nickel, chrome, titanium, or the like in substantial quantities, or if only non-coking coal, anthracite or lignite is available, the Strategic-Udy

process can produce pig iron under these conditions which are technically and/or economically unsuitable for the blast furnace or the submerged arc electric furnace. The significant advantage to a developing economy of using the Strategic-Udy process is that it may use the locally available source of non-coking coals and off grades of iron ore. The same coals (whether lignite, anthracite, or non-coking bituminous) may be used also to produce comparatively low cost electric power. Especially significant to the developing nations is the fact that this process, operating at a capacity of approximately 100,000 metric tons per year, can produce pig iron cheaper than the conventional processes operating at this capacity. In addition, this process can make full use of fine iron ores without sintering.

(d) Scrap Melting - Still another alternative exists for the developing nation, namely, the melting of available scrap. However, a scrap melting operation generally serves as only the beginning of a steel plant since such an installation is dependent upon the continued availability of scrap. In some nations there exists initially sufficient scrap to support such a facility but the scrap gradually disappears and imports of scrap are required, depleting the foreign exchange which most developing nations are attempting to conserve. The process unit in which the scrap melting can take place depends upon many factors, the most important being the source of heat. A cold charge open hearth furnace may be used, fired either by oil or gas. If there is reasonably priced electric power an electric melting furnace is ideal, followed by the usual metal processing facilities as dictated by economics. If electric power is not readily available in sufficient quantities, then the hot blast cupola offers certain advantages for the production of pig iron. The hot blast cupola, however, requires the use of metallurgical grade coke. In some of the developing nations, pending development of a market sufficiently large to support an integrated steel plant, it may be advantageous to start with a scrap melting operation to be expanded later to include more basic metal producing facilities. However, because of the need to furnish scrap iron from local sources on a continuing basis, the plant would have to be small in size and would, therefore, be capable of producing only a limited line of products. If the initial requirements were small enough, however, this initial plant could be designed for later expansion into an integrated iron and steel plant.

C. Steel-Making Process

27. The selection of the process for converting the pig iron or molten iron to steel is also a vital decision. It is dependent on the type of iron produced from the raw materials and the capacity of the installation under consideration. Each of the various available processes has unique advantages and disadvantages.

28. About sixty years ago most steel manufactured in the world was made by the so-called "Bessemer Process" which consisted of blowing air through the bottom of a refractory-lined vessel containing molten iron. In the United States, Bessemer steel was all made in acid or siliceous refractory-lined vessels and it was necessary that the molten iron be low in contaminants such as phosphorus and sulphur, since neither was removed in the process. In some parts of Europe, a similar pneumatic process became widely used with vessels having a basic refractory lining which was necessary because of large amounts of phosphorus in the molten iron which had to be removed by means of a basic flux such as lime. The process of making steel by this method from high phosphorus iron came to be known as the "Thomas Process". Both of these pneumatic processes produced steels limited in their useful application since they are relatively high in nitrogen which was picked up from the air blast.

29. About 1870, the open hearth steelmaking process was invented by Siemens. Adoption of this process in the United States was very rapid and, by 1905, about half of all steel ingots produced in the United States was made by this method. Use of the process continued to spread and, by 1951, it accounted for approximately 87% of the steel producing capacity of the United States. This process permits a wider range of quality steels than the Bessemer Process.

30. Some years ago steel manufacturers began using relatively pure oxygen as the oxidizing agent, the iron being contained in a vessel similar to a Bessemer shell. Oxygen at high pressure was applied to the molten iron by means of a top lance. This process has gained increasing favor in the past 10 years because it makes steel of as high a grade as the open hearth and because, for a new installation, the initial capital investment is likely to be lower.

31. If reasonably priced electric power is available, electric refining furnaces may be economical to use due to their inherent flexibility and adaptability to comparatively low capacities.

32. There are other generally accepted and widely used methods of refining pig iron into steel, but, for the purposes of this paper, the discussion has been narrowed to the better known and more widely used processes.

D. Billets and Slabs

33. The selection of a method for the production of billets and slabs is of vital significance. Billets are normally square bars varying in size from 2" x 2" to 8" x 8" from which merchant products are made.

34. Slabs, rolled to produce flat products such as sheets and plate, vary in thickness up to 12" and in width up to 75". The type of process used to produce these billets and slabs has a direct bearing on the cost of producing the finished products as well as on the initial capital investment.

35. In small size plants where large capital investment cannot be supported, a method of producing billets and slabs directly from the molten steel has been developed; - the continuous casting process. In such a process the slabs and billets are continuously cast and cut into desired lengths by means of an oxygen-acetylene torch.

36. By eliminating the need for ingot molds, soaking pits, blooming and slabbing mills, and billet mills, initial capital investment and production costs are reduced. It is probable that the continuous casting process would be more appropriate for a developing nation whose market is in process of expanding.

E. Rolling Mills

37. It is necessary to determine which combination of rolling mills will most economically produce the immediate requirements and, at the same time, have excess inherent capacity to take care of the future demand predicted by the Market Study. Normally in a developing economy smaller merchant products such as rods for concrete reinforcing, small angles and channels for building construction, and round rods for wire and nails constitute the bulk of initial demand. These items can be produced economically, if nothing more is needed, in a smaller merchant mill. Next, the economy begins to demand larger steel sections and shapes. However, a much larger capital investment is required and, a greater demand for these products is necessary to justify the additional facilities.

38. As the economy continues to develop a market is created for flat products; sheets and plate. The market study will have determined current and future demand of the types of flat products required. Many countries embarking on an industrialization program have need for a small quantity of flat products - sheets and plate for corrugated roofing and siding, black sheet for hollow enamelware, for barrels and cans, and for tinplate. This need may amount to only 40,000 or 50,000 metric tons and, therefore, a large reversing hot strip mill or the even larger capacity continuous hot strip mill could not be justified.

39. A possible solution to this situation and one that has been used in many countries is the hand sheet mill which, as its name implies, uses more manual labor in its application and less highly automated machinery. The hand sheet mill has the advantage of a lower economic break-even point and consequently is well suited to fulfill the requirements of a smaller market.

40. Unit cost of production of the hand sheet mill will be higher than that of a continuous hot strip mill producing above its break-even point but the unit cost could be far less than that of the larger mill if the latter were producing only 40,000 to 50,000 tons of product.

41. It is necessary, therefore, to design the rolling mills to take care of the immediate needs of the market, as projected to the end of the first five years of operation (this will normally be eight to ten years after it has been decided to build the plant) -- so as to produce the most product for the least capital and operating cost.

F. Source of Electric Power

42. The source and cost of electric power is important to the steel-making facility whether it is based on the conventional iron and steel making processes, or based on electrical reduction and refining processes. In the latter cases, it is more important and forms a larger part of the iron and steel-making cost -- supplanting the coal or coke in part. But whatever the iron and steel making processes, the cost of electric power is important to the operation of the rolling mills and the multitude of auxiliaries used throughout the plant. In many nations sufficient local power exists in the form of hydroelectric or thermal plants. The use of these particular sources are, to a large part, dependent upon the availability of power in adequate quantities, and dependability of the supply.

43. In many instances, due to the unusually large demands and an already overloaded grid, it has been found both practical and economical to construct captive power plants. This has the added advantage of giving complete control of the power source to the steel plant management and is not subject to power interruptions due to breakdowns in the distribution system outside the plant boundaries.

G. General Facilities

44. Provision must be made within the plant boundaries for other utilities such as potable and process water, electric lighting and power, sewage, etc. as well as roads, railroad, repair shops, warehouses, first aid stations, and the like. If the steel plant is located in a remote area, it may be necessary to build shops capable of repairing almost any of the equipment in use in the plant. This will necessitate the establishment of the following maintenance departments:

(a) Mechanical
(b) Electrical
(c) Mason
(d) Blacksmith and Welding

(e) Carpentry
(f) Instrument Repair
(g) Locomotive and Car Repair
(h) Auto and Truck Garage

45. The Utility Department controls the supply of water, power, steam, oxygen, compressed air, etc. It is responsible for the maintenance of all potable and process water lines as well as fire lines; for the operation and maintenance of power generation and distribution facilities as well as tie-ins with other utilities.

H. Adequacy of Infrastructure

46. In selecting the location for a steel plant consideration must be given to the availability (or lack thereof) of all facilities (the infrastructure) needed to support such a plant. In general, these facilities may be divided into those required for the people working in the plant and those required to support the plant itself. The workers and their families need housing, schools, churches, hospitals, stores, water, lights, sewage, transportation, and other facilities.

47. The plant requires developed highways, railroads, and/or waterways for low cost transport of raw materials and supplies to the plant, and finished products to the consuming market. Potable and process water must be brought to the plant and effluent taken from it. Electric power, fuel oil, natural gas, or other power sources must be made available.

48. Before any plan can be finalized for the construction of a steel plant, all of the infrastructure problems must be solved - who will furnish the services, or the money to supply them. Wherever possible, it is highly desirable that all supporting facilities (the infrastructure) be supplied to the steel plant so that it is not burdened with the cost of the facilities or their administration. The steel plant is then left to its primary task of making steel.

I. Profitability

49. Because of the heavy initial investment required for a steel plant, large capital loans are needed to finance the construction and operation of the plant. These loans, obtained from private and public financing institutions, must be repaid with interest. In addition, shareholders will demand that they be given a fair return on their investment. Therefore, the steel plant must be designed to hold all costs to the minimum so as to make it a profitable operation.

50. Private enterprise, working in cooperation with government, mindful of its duties to produce efficiently and for profit, should be the goal for the majority ownership of the steel plant. Many governments have stated their intention of supporting private enterprise by agreeing to sell their interests to the private sector as private investment capital becomes available.

51. Profit, of course, is the difference between income (which is the total value of the steel products sold) and cost (which is the sum of the direct operating cost, the overhead expense and the financing charges). Therefore, the selling prices of steel products which create income deserve our consideration. In most instances, it has been found that prices being paid for steel by non-steel-producing countries are high enough to justify construction of local steel plants (provided raw materials, power and other necessities are available). If the plant is small, steel products cannot be provided as cheaply as they can be produced in the huge mills in Europe or America. It may require, therefore, that the new small plant be given a modicum of protection by its government during its formative years. It normally will not be

necessary to raise tariffs, but it may be necessary to continue existing tariffs for a period of years. In addition, provision may have to be made to prevent the sale of steel products in the local market at exceptionally low prices during periods of over-production in the larger mills abroad. This protection may take the form of a program of import licensing for the products produced by the new local steel mill.

52. It is, therefore, essential to the economic viability of a project that decisions as to raw materials, location of the plant, source and cost of electric power and methods of transport, be made strictly on the basis of economics. This is true because a small new mill with its high capital charges, newly trained operating and management personnel, newly developed sources of raw materials and services, must be given every possible assistance to stand on its own feet without subsidy - and to make a profit for its owners, public or private, so that it may grow and expand - and assist in the industrialization of the nation.

J. Corporate and Capital Structure

53. The corporate structure of the steel plant will depend on the source of capital and the policy of the government. In most developing countries there are insufficient funds in the private sector to finance the development of a steel mill, and the local government may furnish some or all of the funds. In such cases, the local government may pledge itself either to take a subordinate position to private owners, or offer to sell its shareholdings to private owners in the future. The capital required to build and operate the plant normally comes from two sources; the shareholders or owners of the business, and long term loans from private and public lending institutions.

54. Although steel is a basic industry, it is not one in which high profits can be expected. At the same time it is an industry in which capital requirements are high. It is desirable, therefore, that loans provide a substantial part of the capital required to build the plant, that these loans be long term, and that the interest rate be reasonably low.

55. A medium size steel plant producing an adequate mixture of steel products has an excellent chance of success provided the following conditions exist:

(a) Adequate market for its output
(b) Suitable long-term debt financing
(c) Reasonably established sales prices for its products
(d) Adequate raw materials and power reasonably priced
(e) A mutual determination by government and business for its success.

56. An important source of long term loan capital has been the various lending institutions in Europe and the United States, both public and private.

57. Another source of financial assistance has been the equipment suppliers who have been willing to extend long term credits for the purchase of their equipment. In some instances these suppliers have assumed a financial interest in the operation by purchasing shares of stock in the company.

58. The raising of capital within the borders of the nation through the sale of stock to insurance companies, banks, and other lending institutions, and the general public is recommended since this insures active participation by those most affected by the results of the steel plant.

59. At the same time, it helps to develop the private sector as a moving force in developing the industrial strength of the nation.

K. Technical and Management Assistance

60. The management and operation of a steel plant is a complex task requiring many highly trained specialists in many different fields. It is not to be expected that all of these qualified specialists will be available in a developing country and it will, therefore, be necessary to import additional specialists. The number of such imported technicians and managers will depend on the local availability of skilled technicians and managers, and the number of local employees who can be trained during the period of plant construction. However, specialists have to be imported at the start to inaugurate an interim program for training local personnel immediately - training in all phases of plant operation and maintenance, as well as training in management and administration not only on-the-job but also abroad. The President, Sales Manager, Plant Manager, Plant Superintendent, Safety Director, superintendents of the various departments, the chief of the laboratory, the operators of furnaces and rolling mills, the superintendents of electrical and mechanical maintenance, must be trained to assume their responsibilities. As soon as they are qualified the imported specialists are released.

61. It is vitally important, therefore, that the company selected to furnish the technical and management assistance to the new steel plant be one with a background and history of achievement in this field where unusual technical ability and previous experience are so vital.

62. The objectives of the technical and management assistance group must be to obtain the most efficient and economical operation of the steel plant and to complete the training of the local employees of the plant at the earliest possible date so that they themselves can progressively assume in the shortest possible time all the management, administrative, and technical positions in the plant.

63. If competent personnel are available for the management, administrative, and supervisory positions in the office and in the plant, then the technical assistance group will furnish only advice and guidance in the execution of their duties. If, on the other hand, such personnel are not available locally, then the technical assistance group will help the steel plant recruit adequate talent from abroad, and supervise the training of local personnel to take over these responsibilities after a period of training. It is necessary that the technical and management assistance group align themselves with the steel plant on a long-term, continuing basis because it takes many years to bring a steel plant into full and efficient operation. When that point has been reached, the plant will undoubtedly have to be expanded to take care of the market for steel products which has been growing rapidly because of the availability of locally produced products at steady prices.

V. CONCLUSION

64. And so, as emphasized at the opening of the discussion, when a developing country has economically and technically usable raw materials and a sufficient market for steel plant products, building its own iron and steel industry will usually benefit its entire economy, expand its industrial base, and accelerate its social progress.

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